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cies, which range even from the shore-region to great depths. These facts add seriously to the difficulties encountered in the attempt to determine approximately the depths at which geological deposits have been found. Dr. Theodore Fuchs has attempted to determine what geological strata should be considered as of deep-sea formation; but, as he defines the deep-sea fauna as commencing at a hundred fathoms, and extending downwards to all depths, his results have little value as indicating the depths of ancient seas, or the extent of upheaval or depression of their bottoms. Mr. John Murray has shown that the depths at which modern deep-sea deposits have been formed can be approximately ascertained by the examination of their microscopical composition, and the condition of preservation of the shells and spicules.

The most important question with regard to life in the ocean, at present insufficiently answered, is that as to the conditions with regard to life of the intermediate waters between the surface and the bottom. The greatest uncertainty and difference of opinion exist as to whether the intermediate waters are inhabited at all by animals, and, if they are inhabited, to what extent; and these intermediate waters constitute by far the greater part of the ocean. Great care should be exercised in drawing conclusions from the depths ascribed to animals in some of the memoirs in the official work on the Challenger expedition. In many instances it is quite possible that a particular specimen may have entered the net at any depth.

With regard to the constitution of the deep-sea fauna, one of its most remarkable features is the general absence from it of paleozoic forms, excepting so far as representatives of the Mollusca and Brachiopoda are concerned; and it is remarkable, that, amongst the deep-sea Mollusca, no representatives of the Nautilidae and Ammonitidae, so excessively abundant in ancient periods, occur, and that *Lingula*, the most ancient brachiopod, should occur in shallow water only. It might well have been expected, that, had the deep sea been fully colonized in the paleozoic period, a considerable series of representative forms of that age might have survived there, in the absence of most of the active physical agents of modification which characterize the coast-regions.

With regard to the origin of the deep-sea fauna, there can be little doubt that it has been derived almost entirely from the littoral fauna, which also must have preceded, and possibly given rise to, the entire terrestrial fauna; yet it is not improbable that we should look to the pelagic conditions of existence as those under which most of the earliest types of animal life were developed. Nearly all the present inhabitants of the littoral zone revert to the pelagic free-swimming form of existence in their early developmental stages. And these pelagic larval forms are in many cases so closely alike in essential structure, though springing from parents widely differentiated from one another in the adult form, that it is impossible to regard them as otherwise than ancestral. The various early pelagic free-swimming forms, represented now mostly only by larvae, gradually adapted

themselves to coast-life, and underwent various modifications to enable them to withstand the beating of the surf on the shores, and the actual modifying alterations of the tides, which, together with other circumstances of coast-life, acted as strong impulses to their further development and differentiation. Some developed hard shells and skeletons as protections; others secured their position by boring in the rocks or mud; others assumed an attached condition, and thus resisted the wash of the waves.

It is because the ancestors of nearly all animals have passed through a littoral phase of existence, preceded mostly by a pelagic phase, that the investigations now being carried on, on the coasts in marine laboratories, throw floods of light on all the fundamental problems of zoölogy. From the littoral fauna a gradual migration must have taken place into the deep sea; but probably this did not occur till the littoral fauna was very fully established, and considerable pressure was brought to bear on it by the struggle for existence. Life, too, must have become abundant in the littoral zone before there could have been a sufficient food-supply in the deeper regions adjoining it. Not until the development of terrestrial vegetation and animal life can the supply have reached its present abundance. Such a condition was, however, certainly reached in the carboniferous period. From the general absence of representatives of paleozoic forms from the deep sea, it is just possible, that, if deep oceans existed in paleozoic periods, they may not have been colonized at all, and that active migration into deep waters commenced in the secondary period. Very possibly the discharges of carbonic acid from the interior of the earth, which Professor Dittmar believes may have been sufficient to account for the vast existing deposits of coal and limestone, may have been much more abundant over the deep-sea beds in the paleozoic period, than at present, and have rendered the deep waters more or less uninhabitable.

RECENT GEOGRAPHICAL DISCOVERY.¹

AFTER some introductory remarks referring to his previous visit to Canada, Gen. Lefroy alluded to the relations of geography to geology as instanced in the changes in the earth's surface within historical times by the operation of geological causes. A recent German writer, Dr. Hahn, has enumerated ninety-six more or less extensive tracts known to be rising or sinking. For example: Mr. R. A. Peacock has accumulated evidence that the Island of Jersey had no existence in Ptolemy's time, and Mr. A. Howarth has collected similar proofs with regard to the arctic regions; and every fresh discovery, notably those of the gallant and ill-fated DeLong and of Nordenskiöld, adds to the number. Professor Hull has reached the conclusion that the land between Suez and the

¹ Address to the geographical section of the British association at Montreal, Aug. 28, 1884, by Gen. Sir J. H. LEFROY, R.A., C.B., K.C.M.G., F.R.S., F.S.A., vice-president of the Royal geographical society, president of the section.

Bitter Lakes has risen since the exodus; and from the Indian survey it is 'almost certain' that the mean sea-level at Madras is a foot lower than it was sixty years ago. From the Chinese annals it is learned that the so-called Hot Lake (Myk-kul) of Turkestan was formed about a hundred and sixty years ago; and there seems no good reason to reject the Japanese legend that Fusi-yama itself was thrown up in the third century before our era.

He then touched lightly on the progress made in our knowledge of the geography of the Dominion of Canada, which comprises within its limits the pole of vertical magnetic attraction, commonly called the magnetic pole, and the focus of greatest magnetic force, also often but incorrectly called a pole. The first of these, discovered by Ross in 1835, was revisited in May, 1847, by officers of the Franklin expedition, whose observations have perished, and was again reached, or very nearly, by McClintock in 1859, and by Schwatka in 1879. Neither of these explorers, however, was equipped for observation. The utmost interest attaches to the question whether the magnetic pole has shifted its position in fifty years; and, although far from rating the difficulty lightly, it is probably approachable overland, without the great cost of an arctic expedition. The second, which is in the neighborhood of Cat Lake, has never been visited, although Dr. R. Bell was within two hundred miles of it. These two objects, and the exploration of an almost unknown tract of some seventy thousand square miles, lying east of Athabasca River, were declared worthy of the scientific ambition and energy of the dominion. He alluded also to the extent and importance of Lake Misstassini, which has recently been discovered in no very remote part of the dominion, — a lake rivalling Lake Ontario, if not Lake Superior, in magnitude.

He then mentioned the report of Lieut. R. P. Rodgers, U. S. N., on the state of the canal-works at Panama so lately as Jan. 25 last, and read the official returns of the amount of excavation during the months of October, 1883–March, 1884, by which it appeared that the quantity excavated per month had greatly increased during that time, and shows that the limit has not been reached. The two great problems which await solution are, how to deal with the River Chagres, and how to manage a cutting nearly four hundred feet deep. The Chagres, which is subject to great fluctuations of volume, it is proposed to arrest by an enormous dike, 1,050 yards long at the bottom, 2,110 yards at the top, 110 yards thick at the base, and 147 feet in the greatest height; the overflow of the reservoir so constructed to be led away by two artificial channels, partly utilizing the old bed. The cutting, nearly five hundred feet wide at the top, it is proposed to attack by gangs working on twelve different levels at the same time, one each side of the summit, dividing the width at each level into five parallel sections. Thus there will be a hundred and twenty gangs at work together, and it is confidently hoped that the whole will be really finished in 1888.

He next turned to another quarter, and referred to

the mission intrusted to Mr. Joseph Thomson last year, in East Africa, by the Royal geographical society. After an unsuccessful start from Zanzibar in March of last year, — in which, however, he reached Kilima-njaro, and ascended it about nine thousand feet, — he returned to the coast from Taveta, and started again in July, this time from Mombasa. We are not yet fully acquainted with his route; but we know that he again reached the great mountain reputed to have an elevation of more than twenty thousand feet; that thence he reached the east side of Lake Nyanza; that he is the first who has stood on the shores of Lake M'Baringo; that thence, always among natives who had never before seen a white man, he reached Mount Kenia, reputed to be eighteen thousand feet high, and found his way back to the coast without any conflict or loss of life by violence; and this after a journey of about five hundred miles, nearly the whole of it through a country previously unknown to geography. Before Mr. Thomson's return to Zanzibar, Mr. H. H. Johnston, under direction of a committee of this association, whose plans are devoted primarily to the investigation of the fauna and flora of Kilima-njaro, had left Zanzibar in good health, and with every hope of ultimate success.

The president then alluded to the unfortunate French expedition of Col. Flatters, who, together with several other officers and men, was killed by the Youaregs in February, 1881. The French travellers have emphasized the probable consequences of the rapid progress of the religion of Mohammed among the African races of the northern equatorial zone, which in time may reach the populous basin of the Kongo, and may greatly affect the white settlements and missionary enterprises in Central Africa hereafter.

The Upper Kongo, from Stanley Falls to Stanley Pool, is now pretty well known; but as to its tributaries, much remains to be learned. Mr. Stanley has discovered two new lakes. The labors of that energetic traveller, Mr. de Brazza, have to a great extent cleared up the geography of the region included between the Kongo and the Ogowé, from the equator southwards; and there are now said to be twenty-two trading-stations in this part of the country. We are not informed what commerce exists. Higher up, but still to the north, Mr. Stanley has ascended the Aruwimi about a hundred miles, without having solved a question of no little interest; namely, whether it is identical with the Wellé, and takes its rise in the same watershed which feeds the White Nile, or whether we have not, beyond its sources, a drainage system, as yet untraced, but which may connect together a number of rivers whose relations to one another, and whose final outlet, are alike unknown. Lupton Bey reported, nearly two years ago, that a very large lake had been visited by one of his native subordinates west of the Aruwimi; and it is, in his opinion, probable that the Wellé flows into it. The southern basin of the Kongo has been crossed from Koando to Nyan-givé by the late Dr. Pogge and Lieut. Wissman, the latter of whom continued his journey by Yabora to Zanzibar. He brings confirmation of the often re-

ported existence of a dwarfish race on the upper waters of the Sankuru.

Proceeding southward to the region of Portuguese exploration, Messrs. Britto, Capello, and Ivens, who reached the Upper Quango in 1878, returned last January to Loando, with the intention, it is said, of descending one of its great tributaries. They are now on the Kumene. Dr. Pogge compares the climate of Mussumba on the 8th parallel, in the month of December, to that of North Germany; and the fact illustrates, what we learn from so many other quarters, that much of the interior of Africa belongs, by reason of its elevation above the sea, to a far more temperate zone, and is better suited to the European constitution, than its geographical position promises. The terrible prevalence of fever, which has cost so many lives, will probably be mitigated in time, and by improved accommodation. The hills are comparatively free from it. The progress already made in the white occupation of Central Africa was well shown by a table of actual centres of trade, or missionary institutions (a hundred and twenty in number), now established there.¹

He then took up the Russian project for diverting the Oxus, or Amu Darya, from the Sea of Aral to the Caspian; the level of which, according to Mr. George Kennan, a recent American traveller, is steadily but slowly falling, notwithstanding the enormous quantity of water poured in by the Volga, the Ural, and other rivers. In fact, Col. Vinukof says, that the Caspian is drying up fast, and that the fresh-water seals, which form so curious a feature of its fauna, are fast diminishing in number. At first view, there would not appear great difficulty in restoring water communication, the point where the river would be diverted being about two hundred and sixteen feet above the Caspian; but accurate levelling has shown considerable depressions in the intervening tract. Certainly the Oxus, or a branch of it, once flowed into the Caspian Sea. Prof. R. Lentz, of the Russian Académie impériale des sciences, sums up his investigation of ancient authorities by affirming that there is no satisfactory evidence of its ever having done so before the year 1320. Passages which have been quoted from Arab writers of the ninth century, only prove, in his opinion, that they did not discriminate between the Caspian Sea and the Sea of Aral. There is evidence that in the thirteenth and fourteenth centuries the river bifurcated, and one branch found its way to the Caspian, but probably ceased to do so in the sixteenth century. This agrees with Turkoman traditions. We may safely conclude that the thing will not be done; nor is it at all probable that Russian finances will permit the alternative proposal of cutting a purely artificial canal by the shortest line, at an estimated expense of from fifteen to twenty million roubles.

One of the finest feats of mountaineering on record was performed last year by Mr. W. W. Graham, who reached an elevation of twenty-three thousand five hundred feet in the Himalayas about twenty-nine hun-

dred feet above the summit of Chimborazo, whose ascent by Mr. Whymper, in 1880, marked an epoch in these exploits. Mr. Graham was accompanied by an officer of the Swiss army, an experienced mountaineer, and by a professional Swiss guide. They ascended Kabru, a mountain visible from Darjeeling, lying to the west of Kanchinjunga, whose summit still defies the strength of man.

The primary triangulation of India, commenced in the year 1800, is practically complete. Much secondary triangulation remains to be executed, but chiefly outside the limits of India proper. The Pisgah views, by which some of the loftiest mountains in the world have been fixed in position, sometimes from points in the nearest Himalayas, a hundred and twenty miles distant, only serve to arouse a warmer desire for unrestrained access. The belief, long entertained, that a summit loftier than Mount Everest exists in Thibet, is by no means extinct; but it is possible that the snowy peak intended may prove eventually to be the Mount Everest itself of the original survey.

The Upper Oxus has now been traced from its sources in the Panjah, chiefly by native explorers; and to them we may be said to be indebted for all we know of Nepaul, from which Europeans are as jealously excluded as they are from the wildest central Asian kanate, although Nepaul is not so far from Calcutta as Kingston is from Quebec.

The Australian continent has been crossed again from east to west by Mr. Mills, who started with thirty camels attended by five Afghan drivers. Six of them died from the effects, as was supposed, of eating poisonous herbage. Mr. Mills did not deviate much from the tracks of the late Mr. W. C. Gosse and of Mr. J. Forrest: his journey has therefore added little to previous geographical knowledge; but it has helped to make the route better known, and afforded fresh evidence that the value of the camel in those terrible Australian sahara is in no degree less than it is where he has long been known as the 'ship of the desert.' Another traveller, Mr. C. Winnecke, starting from the Cowarie station on the Warburton River, in 28° south, has traversed about four hundred miles of new country in a northerly direction, and made a sketch-map of forty thousand square miles, up to Goyders Pillars, — a remarkable natural feature in the Tarleton Range. He, too, owed his success to the employment of camels. The international circumpolar expeditions have added, perhaps, to local knowledge, especially as regards the climate and means of supporting life at various stations, but not much, so far as reported, to geography generally. To this remark, however, a brilliant exception must be made. The distinction of the nearest approach to the north pole, yet made by man, has been won by the late Lieut. Lockwood and Sergt. Brainerd, of Lieut. Greely's expedition. They reached on May 13, 1882, an island not before known, in latitude 83° 24' north, longitude 44° 5' west, now named after its discoverer. This is four or five miles beyond Capt. Markham's farthest point (83° 20' north), and it appears to be by no means the only geographical achievement which in some measure

¹ A list of these is given in an appendix to the address, with their geographical positions collated with great care.

rewards the painful sufferings and losses of the party. Lieut. P. H. Ray, U.S.A., has also rectified many details of the map about Point Barrow, and discovered a range of hills, which he has named the Meade Mountains, running east from Cape Lisburne, from which at least two streams, unmarked, flow into the Polar Sea. We may expect similar service from the Italian parties at Patagonia, and from the Germans in South Georgia. Since the voyage of the Challenger, no marine researches have been more fruitful of results than those of the Talisman and the Dacia. The first was employed last year by the French government, to examine the Atlantic coasts from Rochefort to Senegal, and to investigate the hydrography and natural history of the Cape Verde, Canary, and Azores archipelagoes. The other ship, with her companion the International, was a private adventure, with the commercial purpose of ascertaining the best line for a submarine telegraph from Spain to the Canaries. These last two made some five hundred and fifty soundings, and discovered three shoals, one of them with less than fifty fathoms of water over it, between the continent of Africa and the islands. If we draw a circle passing through Cape Mogador, Teneriffe, and Funchal, its centre will mark very nearly this submarine elevation: the other two lie to the north of it. The Talisman found in mid-ocean but sixteen hundred and forty fathoms, among soundings previously set down as over two thousand fathoms.

Gen. Lefroy then spoke of the extension of railways in Mexico, South America, Africa, and Asia, and of the agreement to refer local time on this continent to a succession of first meridians, one hour apart. The next step will not be long delayed: that is, the agreement of the civilized world to use one first meridian; Paris, Ferrol, Washington, Rio de Janeiro, gracefully, as we venture to hope, giving that precedence to Greenwich, which is demanded by the fact that an overwhelming proportion of the existing nautical charts of all nations, and of maps and atlases in most of them, already refer their longitudes to that meridian. No other change would be so easy, or so little felt.

THE GENERAL STATISTICS OF THE BRITISH EMPIRE.¹

WE will group our statistics under the following headings: 1°. The area consisting of widely extended regions; 2°. The inhabitants of these many lands; 3°. The works of man as they are displayed in this vast theatre of action.

First, then, the area of the British Empire may be set down at more than eight and a half millions of square miles. Out of this total, there are only a hundred and twenty thousand square miles in the United Kingdom. There are a million and a half of square

miles in India; and the remainder, or seven millions, belong to the colonies and to the scattered possessions.

But there are other regions which have fallen, or are falling, under its political control more or less, such as Egypt, including a part of the Egyptian Sudan, some districts in southern Arabia, a part of Borneo, Zululand, the Transvaal, Afghanistan, and Beluchistan. Thus the total area, directly or indirectly, under the authority of the British empire, may be taken at nearly ten millions of square miles, or about one-fifth of the fifty millions of square miles composing the habitable globe.

As might be expected in an empire whereof the real basis of power is maritime, the coast-line is of an extraordinary length, to be measured by about 28,500 miles, with forty-eight large harbors. For the whole of this length, marine surveys have been prepared. But greatness does not depend on area alone, and there is a vast range in the scale of value for lands. Out of the ten millions of square miles, hardly one-fifth is cultivated or occupied, in the widest use of the term 'occupation.' In India, which is popularly, though not quite correctly, supposed to be thickly populated, the cultivable waste is not less than a quarter of a million of square miles.

In the second place, respecting the inhabitants, the total population amounts to 305,000,000 of souls in those regions which are included directly in the empire. This mass of humanity is composed of many diverse nationalities, a cardinal distinction between which is that of religion. Christianity, the religion of the dominant race, is professed by one-seventh of the whole. The religion which includes the largest number is Hinduism. There are 188,000,000 of Hindus; and it may, indeed, be said that the whole Hindu race is subject to the British crown. The Hindus, then, form more than a half of the total population in the empire. The number of Buddhists is not considerable, amounting to about 7,000,000. The imperial area is, on the whole, but sparsely populated, with an average of only thirty-three persons to the square mile, notwithstanding the mighty aggregate of the people, as the population is most unequally distributed.

The third and last heading relates to the works of man, his riches and power, his industrial and commercial operations.

One, among the primary tests of national resources, is the public revenue. The total of yearly revenue and receipts, governmental and local, amounting to £264,000,000 sterling, is unequalled, but falls at the moderate rate of one and a quarter pounds sterling per head of the total of British subjects. There is a large revenue received throughout the empire for local purposes. This income (including various receipts, but excluding loans) amounts to hardly less than £61,000,000 sterling yearly; and the greater part is levied by direct taxation.

Another test of power relates to the provision for external defence and internal protection. Now the men trained to arms in the British empire may be stated at 850,000, including the regular British forces

¹ Abstract of an address to the economic science and statistics section of the British association at Montreal, Aug. 28, 1884, by Sir RICHARD TEMPLE, Bart., G.C.S.I., C.I.E., D.C.L., LL.D., F.R.G.S., president of the section.